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Angler Catch and Fishing Effort Diary: 1983 and 1984 Pilot Study at Plummer's Great Slave Lake Lodge, N.W.T.

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by

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ABSTRACT

Thompson, P.C., L.E. Anderson, and H.R. Ellison. 1988. Angler catch and fishing effort diary: 1983 and 1984 pilot study at Plummer's Great Slave Lake Lodge, N.W.T. Can. Tech. Rep. Fish. Aquat. Sci. 1631: v + 27 p.

An angler diary program was tested at a large sport fishing lodge over two fishing seasons to determine whether it is a cost effective alternative to the standard creel census for collecting angling catch and effort data. Diaries were returned by 286 guests (63%) in 1983 and by 264 guests (59%) in 1984. The response rates are comparable to those achieved by the Department of Fisheries and Oceans' standard creel census studies, but the data contained more recording errors. Based on the angler diary data; estimates of the total harvest of all guests at the lodge (423 in 1983 and 446 in 1984) were made with a 95% confidence interval of plus or minus approximately 6%. An operational diary program is estimated to cost about $ 3 400. The estimated cost of a standard creel census study is about $ 6 000, but also involves the collection of biological data on the fish stocks.

Key words: angler diary; angling; catch/effort; cost effectiveness; fishery management; monitoring; game fish; creel census; sport fishing statistics.

RÉSUMÉ

Thompson, P.C., L.E. Anderson, and H.R. Ellison. 1988. Angler catch and fishing effort diary: 1983 and 1984 pilot study at Plummer's Great Slave Lake Lodge, N.W.T. Can. Tech. Rep. Fish. Aquat. Sci. 1631: v + 27 p.

On a mis à l'essai un programme visant à déterminer si le carnet du pêcheur constitue une solution de rechange avantageuse aux relevés standard de pêche sportive pour la collecte de données sur les captures et l'effort de pêche. L'expérience, qui a duré deux ans, a été réalisée dans un important camp de pêche. En 1983 et 1984, le nombre de pêcheurs ayant retourné leur carnet a été de 286 (63%) et de 264 (59%), respectivement. Le taux de réponse a été comparable à celui qu'obtenait le ministère des Pêches et des Océans pour les relevés standard de pêche sportive, mais les données des carnets comportaient un plus grand nombre d'erreurs d'enregistrement. En se basant sur le données recueillies dans les carnets des pêcheurs sportifs, on a évalué la récolte totale des tous pêcheurs du camp (423 en 1983 et 446 en 1984) avec un intervalle de confiance de 95% ± environ 6%. On estime que l'application d'un programme de carnet du pêcheur coûte environ 3 400 $. Le coût d'une étude standard par relevés de pêche sportive est estimé à environ 6 000 $, mais une telle étude inclut aussi la collecte de données biologiques sur les stocks de poissons.

Mots-clés: carnet du pêcheur; pêche sportive; pêche à la ligne; prises/effort; gestion des pêches; contrôle; poisson de pêche sportive; relevé de pêche sportive; statistiques de pêche sportive.

INTRODUCTION

Great Bear and Great Slave lakes in the Northwest Territories are two of Canada's most important northern sport fisheries. Because of the remote and uninhabited location of these lakes, access by fishermen is almost entirely through commercial sports fishing lodges. Currently, there are six lodges (five operating) on Great Bear Lake and 4 lodges on Great Slave Lake. These lodges operate for eight to 12 weeks between June and September each year, serving approximately 2 400 guests with fourto eight day angling trips.

The fisheries management goal for these lakes is to maintain the high quality trophy angling they currently provide. Sustainable yields of large fish, especially lake trout, are low. The Department of Fisheries and Oceans (DFO) must therefore carefully monitor catch, fishing effort, and fish stocks to ensure that the management goal is met.

Angler catch and effort data have traditionally been supplied by creel censuses. These were first conducted on Great Bear and Great Slave lakes in 1972 and covered all lodges. The costs of conducting creel censuses at these remote locations have been higher than at more southerly locations, so financial as well as personnel constraints have limited them to a rotational coverage of one lodge on each lake per year since 1975 (Gillman and Roberge 1982). This limited monitoring is considered unsatisfactory by both DFO and some of the users of the lakes (DFO 1985).

In 1982 the Department undertook a study (Jacobson et al. 1983) to examine alternative monitoring methods. It recommended that DFO use either an angler diary or a guide diary as a statistically sound alternative to the creel census method of providing angler catch and effort data from remote lodge-accessed lakes.

DFO conducted a pilot study in 1983 and 1984 designed to test and compare the two methods and determine their costs. The angler diary was tested in both years at two lodges: one was large (capacity > 40 guests) and offered guiding services, and the other was small (capacity < 15 guests) and did not employ guides. The guide diary was tested at two large lodges on Great Bear Lake, one in each of the two years.

This report examines the pilot study of the angler diary at Plummer's Great Slave Lake Lodge (the large lodge) in 1983 and 1984. The objectives of the study were to determine:

- whether or not anglers would participate at an acceptable response rate,
- the quality of the data provided by anglers,
- how to get the level of co-operation needed from the lodges to operate the diary program,
- whether the results would compare with those from the traditional creel census,
- an effective design for the angler diary, and
- the costs of the angler diary method.

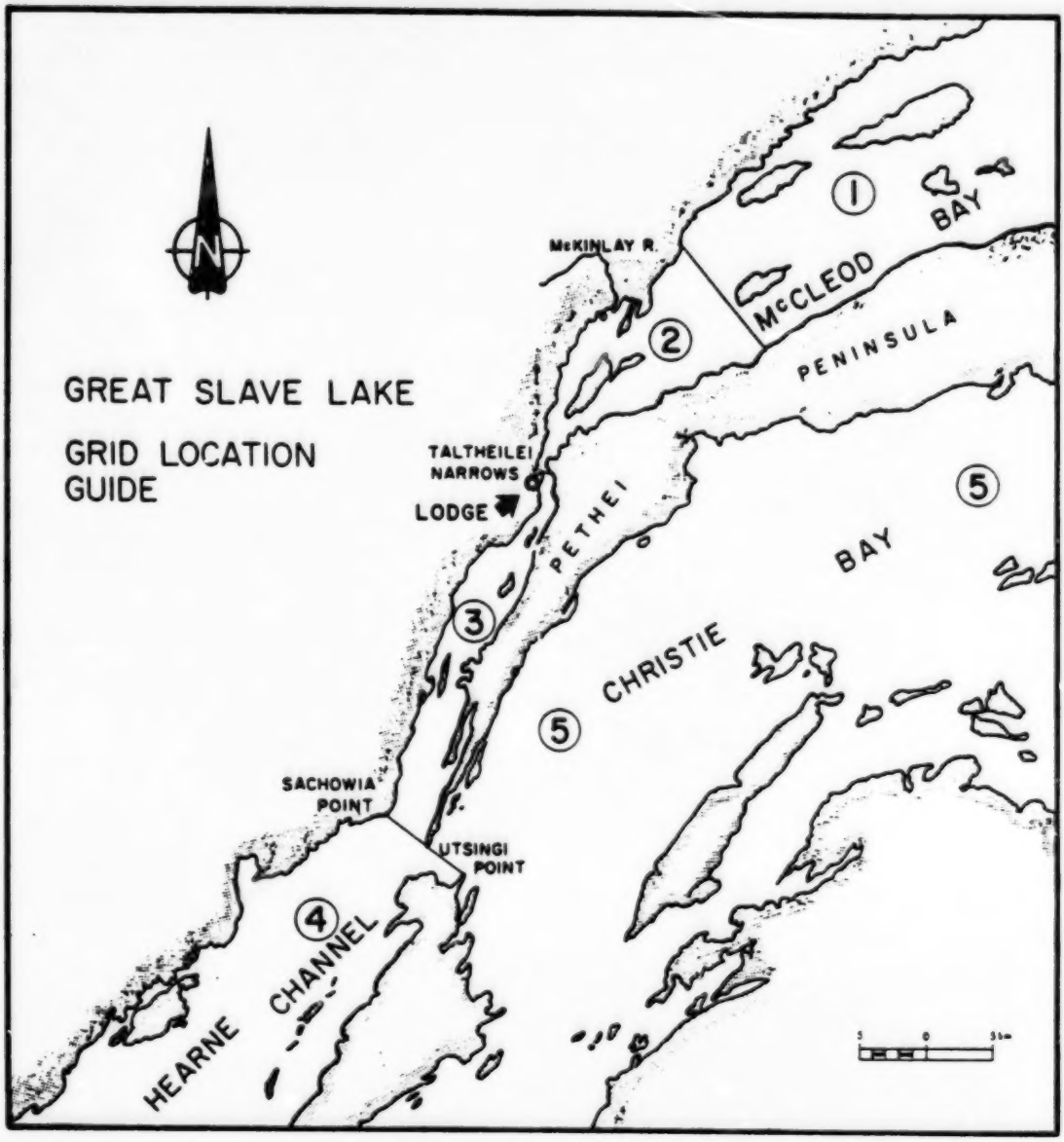

Fig 1. Fishing areas used in 1983.

METHODS

In contrast to a creel census, the angler diary program operated in the absence of DFO staff. Catches and fishing effort were recorded in angler diaries by the lodge's guests, and the lodge was paid to distribute and collect the diaries and manage the program.

Anglers who completed and turned in their diaries were promised that they would be returned after DFO had copied their contents. This encouraged anglers to participate as the diary provided a keepsake of their fishing trips. As an additional incentive, anglers were also promised a crest and a lapel pin for completing the diary.

ANGLER DIARY DESIGN

To minimize the errors from inaccurate recollection, (a problem that can be serious when catch rates are high) the diary was initially designed so that anglers could easily record their daily fishing activity as it progressed. The 1983 version of the diary was a small (9 cm by 18 cm) 20 page booklet. It was made of waterproof and rip-resistant paper and had a built-in pen pocket. To allow anglers to record their catches as they occurred, data could be recorded by simply circling codes for species, areas, and catch uses. Fishing effort was also recorded by circling codes and a non-fishing day could be indicated by a check-mark in a box.

Sample pages of the 1983 version of the diary are shown in Appendix 1. Sixteen pages, two for each of eight days at the lodge, provided space for anglers to record their daily fishing activity and any comments they might wish to make. On the overleaf of the diary's cover there were a set of instructions asking anglers to:

- write their name on the diary,
- indicate if they did not fish on any day of their stay at the lodge,
- record the date for each day,
- record the number of fish of each species caught and landed,
- record the number of fish of each species that were released, kept, or used as a shore lunch,
- record the number of hours spent fishing for each species, and
- record the locations they were fishing and where fish were caught.

A map of the region of Great Slave Lake used by the lodge showing the specific areas for which the anglers were to record their catch and effort was on the centre two pages of the diary (Fig. 1).

It was clear after the first year of the pilot study that anglers did not take their diaries with them when they went fishing and were instead filling them out at the end of the day, back at the lodge. Futhermore, the errors anglers had made in filling out the diaries in 1983 seemed to be related to the circling method of recording catches. This was abandoned in the 1984 diary and replaced with a table format that required anglers to write the number of fish caught, kept, released and eaten as a shore lunch in each area. The effort data were recorded in the same way as in the 1983 diary, but the order of the information required was changed so that anglers had to first indicate where they had fished, then for how long, and finally, what they were fishing for. On both the catch and effort portions of the format, a new area called "off map" was added to allow

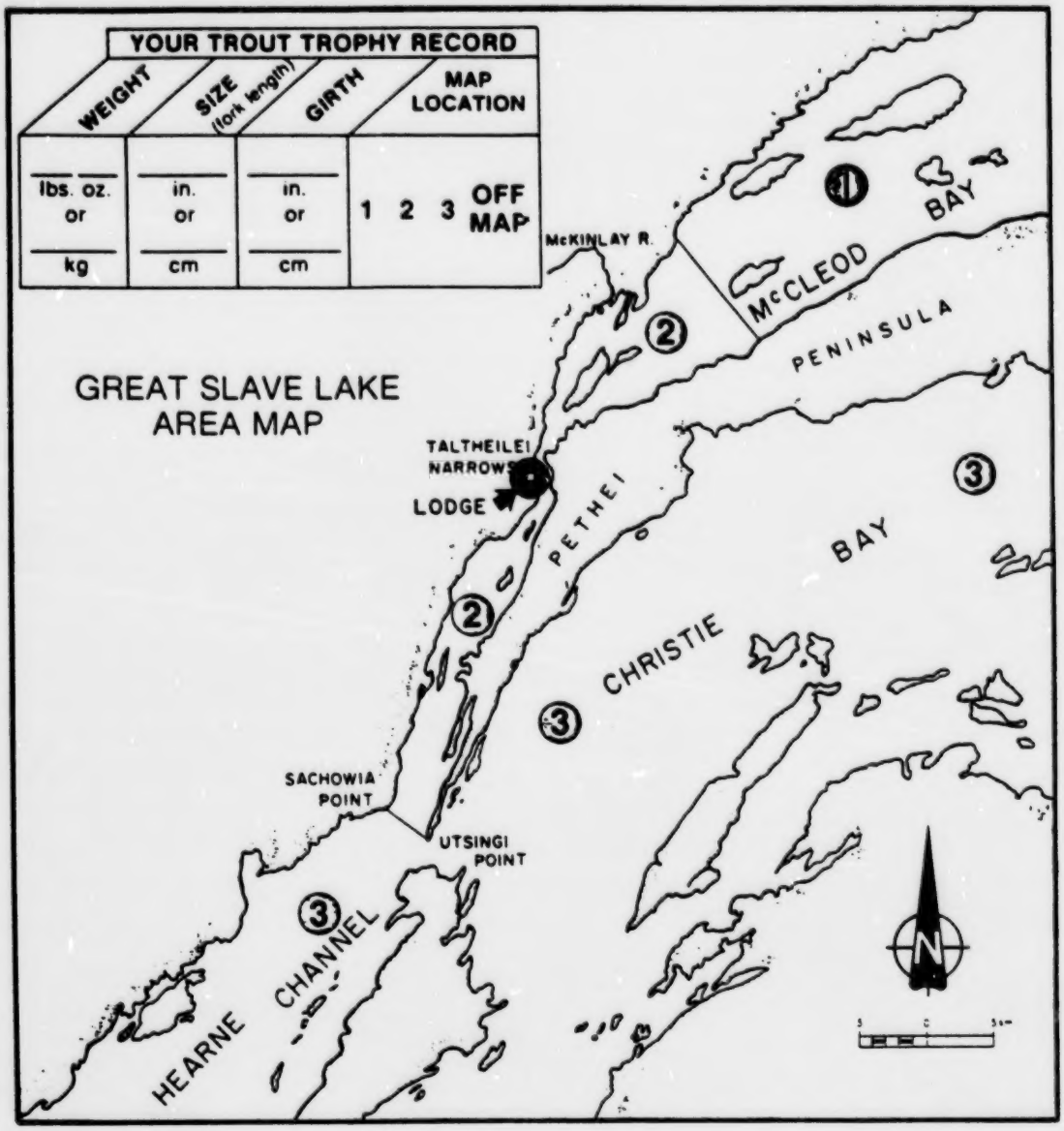

Fig 2. Fishing areas used in 1984.

anglers to record their fishing activities when they were flown out to other lakes. Sample pages of the 1984 version of the diary are shown in Appendix 2.

The new format required less space, shortening the diary to 16 pages. Twelve pages, 1½ for each day, were for recording fishing activities and comments. The map remained on the centre two pages, but was changed to show only three areas instead of five (see Fig. 2). A calendar, intended to help anglers record the dates correctly, and the catch, size and possession limits were added to the last pages of the diary. To make room for these additions, and to make it more prominent, the trophy catch record was moved to a corner of the centre pages with the map. The instructions remained on the overleaf of the front cover, but were rewritten to provide more detail. A sample page of the diary filled out correctly was put adjacent to the instructions in an attempt to further clarify how to fill it out.

The other features intended to allow anglers to take the diary with them in the boat were also abandoned. In 1984 the diary had no pen pocket and was made of ordinary bond paper.

HOW THE DIARY PROGRAM OPERATED

Guests at the lodge (except for those providing their own transportation) were booked for either eight days (Saturday to Saturday), five days (Saturday to Wednesday), or four days (Wednesday to Saturday). The Saturday arrivals were scheduled for 1500 h and the Wednesday arrivals were scheduled for 0900 h. Guided fishing generally began on the first day.

The lodge manager introduced and promoted the diary program after he had explained the camp rules and fishing regulations to each group of guests. His promotion was to include the following points:

- fish harvest data were needed for effective fisheries management and conservation,
- the diaries would be returned to the anglers after DFO had copied their contents,
- participating anglers would be given a crest and a lapel pin,
- accurate and complete records were essential, and
- the lodge supported the program and encouraged their guests to participate.

DFO supplied the lodge with brochures and posters reinforcing this message. The brochures were distributed with the diaries and the posters were placed in the guests' rooms and other locations around the lodge.

When the lodge manager distributed the diaries, he told the guests about the instructions on the first page, that questions about the diary could be answered by his staff, and that there was a drop box in the main lodge where completed diaries should be deposited.

The lodge also completed a control sheet for each group of anglers by recording their names, addresses and lengths of stay at the lodge. This provided a count of all guests and their total days at the lodge. Those who participated in the program were indicated by recording the serial number of their returned diaries beside their names. The completed diaries and control sheets were then sent to DFO in Winnipeg.

Operation of the program involved only two lodge staff members. The camp manager was responsible for the promotion and the distribution of the diaries, and the fish shed operator filled out the control sheets, answered any questions anglers had about the diary, and ensured all diaries were collected before the guests left the lodge.

ESTIMATING TOTAL CATCH AND EFFORT

Like most survey methods, the angler diary does not collect data from all anglers so total harvest and fishing effort must be estimated. Because respondents participated voluntarily, it was possible that they may have differed, on average, in some material respect from the non-respondents. The estimates of total catch and effort would have then been subject to what is called response bias (Cochran 1963). For example, if the non- respondents were not as keen or as successful anglers as the respondents, the total catch and effort estimates are likely to be high.

To determine whether or not non-response bias existed, a random sample of the non-respondents were telephoned and asked what their total fishing effort and catch was on each day of their fishing trip. The data was then compared to that provided in the diaries and tested for significant differences. However, because the non-respondents could not always be interviewed immediately after their fishing trips, recall bias, which results from inaccurate recollection of prior events (Hansen et al. 1953), could effect the results of this test. It was therefore necessary to determine whether any significant difference between the data collected from the non-respondents and that provided by the respondents could be attributed to non-response bias or was actually recall bias.

Telephone interviews were also conducted to collect data from a random sample of respondents and then compared with the data they had recorded in their diaries. The difference between them provided an indication of the extent of the recall bias.

The sample of non-respondents was divided into those who were at the lodge eight days and those who were at the lodge four or five days. The mean total catch and effort of these two groups were compared with the mean total catch and effort of the eight day and the four or five day guests who had returned completed diaries. The methods used to collect and analyse the data are outlined in Appendix 3. The results of this analysis indicate that if recall bias is accounted for, non-response bias is not a significant problem for the angler diary program.

Some respondents did not fill out their diaries completely and this may have also affected the accuracy of the total harvest and effort estimates. For example, if an angler failed to complete his or her dairy for a day that was actually active and successful, it would be counted as a non-fishing day and could lead to an under-estimation of total catch and effort. Because of incomplete diaries, 46 respondents were removed from the sample in 1983 and 62 were removed in 1984.

Total harvest and effort estimates were calculated using a standard ratio estimate technique. The ratio estimate is thought to provide a more precise estimate of total catch and effort than alternatives like simple or stratified expansions (Cochran 1963). The rationale for this rests with the fact that the control sheets provided complete data on the number of days at the lodge for all

guests (in total and severally) and that catches and fishing effort are clearly highly correlated to the number of days in a guest's stay. The estimate can be shown algebraically as follows:

$$\hat{C} = \frac{\bar{c}}{\bar{d}} \times D \qquad (1)$$

$$\hat{E} = \frac{\bar{e}}{\bar{d}} \times D \qquad (2)$$

where: $\hat{C}$ = estimated total catch
$\hat{E}$ = estimated total fishing effort
$\bar{c}$ = sample mean catch
$\bar{d}$ = sample mean days at the lodge
D = total number of days at the lodge of all guests.

The total number of days at the lodge of all guests D is the summation of the lengths of stay recorded on the control sheet across all guests. The mean catch $\bar{c}$ and mean number of days $\bar{d}$ are calculated from the sample by dividing the sample totals by the number of anglers in the sample.

RESULTS

PARTICIPATION IN THE DIARY PROGRAM

In 1983 Plummer's Great Slave Lake Lodge served 423 guests who stayed a total of 2 319 days. Four hundred and forty-six guests were served in 1984 and they stayed a total of 2 503 days (Table 1).

The lodge's operating season was from June 22 to August 20 in 1983 and from June 23 to August 26 in 1984. The pilot study covered the entire 1984 season as planned, but in 1983 the lodge manager became ill late in the season and his replacement did not continue the program. As a result, the response rate dropped sharply in the second last week and was zero in the last week of the 1983 season.

Tables 2 and 3 show the number of respondents and the response rates by week for 1983 and 1984 respectively. Both the total response rate and the response rate after the anglers with incomplete diaries were removed from the sample are shown for each year.

POPULATION ESTIMATES

The total effort and catch estimates and the corresponding confidence intervals are shown in Table 4.

Table 1. Number of guests and guest days, 1983 and 1984.

Week of Stay	1983		1984	
	Number of Guests	Number of Guest Days	Number of Guests	Number of Guest Days
1	29	116	48	239
2	78	369	74	346
3	78	375	71	324
4	34	272	45	360
5	33	256	33	248
6	23	184	38	268
7	62	325	59	326
8	74	326	50	248
9	12	96	28	144
Total	423	2 319	446	2 503

Table 2. Total number of respondents, number of respondents with complete diaries, and response rates, 1983.

Week of Stay	Total Number of Respondents	Number of Respondents with Complete Diaries	Response Rates (%) All Respondents	Respondents with Complete Diaries
1	26	24	90 %	83 %
2	64	57	82 %	73 %
3	57	49	73 %	63 %
4	30	23	88 %	68 %
5	25	21	76 %	64 %
6	20	10	87 %	43 %
7	33	25	53 %	40 %
8	13	13	18 %	18 %
9	0	0	0 %	0 %
Total	268	222	63 %	53 %

Table 3. Total number of respondents, number of respondents with complete diaries, and response rates, 1984.

Week of Stay	Total Number of Respondents	Number of Respondents with Complete Diaries	Response Rates (%) All Respondents	Response Rates (%) Respondents with Complete Diaries
1	35	30	76 %	63 %
2	29	19	39 %	26 %
3	42	32	58 %	45 %
4	24	13	56 %	29 %
5	20	14	61 %	42 %
6	34	27	89 %	71 %
7	32	26	54 %	44 %
8	26	24	52 %	48 %
9	21	16	75 %	57 %
Total	263	201	59 %	45 %

Table 4. Population estimates of total fishing effort and catches, 1983 and 1984.

	1983 Population Estimate	95% Confidence Interval	1984 Population Estimate	95% Confidence Interval
Angler Hours	11 754.5	± 321	13 926.4	± 536
Total Catch	7 797.6	± 426	10 355.3	± 702

DATA ERRORS

A total of 205 respondents in 1983 and 193 in 1984 made at least one error or omission in filling out their diaries. These resulted in ambiguous data on the areas fished, the species fished for and caught, and the use of the catch. In some cases the errors could be corrected, in others they were reported as unknown species or areas.

Corrections were sometimes obvious because the format of the diary required some repetition in the recording of species and areas. For example, an angler may have indicated that he caught five lake trout and no other species while fishing for three hours, but neglected to specify that his effort was targeted on lake trout. The obvious correction is to record three hours of fishing effort targeted on lake trout. Corrections of this type were possible on 186 of 201 days with errors in 1983 and 176 of 292 days in 1984.

In other cases error corrections were possible only after certain assumptions were made. In 1983 there were 48 days where anglers had recorded catches, but had failed to correctly record the catch use (releases, kept fish, and fish eaten for shore lunches). First, it was assumed that anglers took the daily limit (two for lake trout, five for northern pike and arctic grayling). The catches were then divided between those kept for shore lunches and those kept to take home based on whether the weekly limit (three for lake trout, 10 for northern pike and arctic grayling) had been reached. If it had, the catch was assumed to have been used for shore lunch. Otherwise it was assumed that it was kept to take home.

The results of these corrections were statistically tested to see if they were significantly different from the catch uses recorded correctly. This test (see Appendix 4) showed no difference, indicating that the assumptions were reasonable.

In 1984 there were also errors in recording the uses of the fish caught, but because of the different design of the diary, they were of a different type. On 120 days, the total number of fish caught was not equal to the sum of the numbers recorded to have been kept, released or used as shore lunch. These were all corrected. If the sum of the numbers recorded to have been kept, released or used as shore lunch was greater than the recorded catch, then the catch was increased. If the catch was greater than the sum of the uses, then the uses of the extra fish were estimated based on the daily and weekly catch limits in the same way corrections were made in 1983.

PILOT STUDY COSTS

About $ 12 900 was spent on the pilot study in 1983, but this is not representative of the expected cost of an ongoing diary program. The most significant expenses were due to the experimental nature of the pilot study, relating to the design of the program and the diary, and to DFO's field observations of how it operated. In 1984 the diary only had to be modified, and no DFO staff travelled to the lodge to observe the operation of the program. This resulted in a total cost of only $ 5 330, less than half that of the previous year.

Payments to the lodge

In both years the lodge was paid a promotional fee and a program management fee. The promotional fee consisted of $ 500 for distributing the brochures and hanging the posters, and $ 0.50 per returned diary for the manager's verbal promotion to each group of guests. The program management fee included a payment of $ 1.00 per guest for distributing the diaries and completing the weekly control sheet, and $ 0.50 per returned diary for collecting the diaries and ensuring that they were complete, legible and accurate. A total of $ 1 135 was paid to the lodge for these services in 1983 and $ 1 189 in 1984.

Costs of materials

The materials used in the study were the diaries, ball-point pens, brochures, posters, crests and pins. At a cost of $ 5 400 in 1983, the diaries were the most expensive. But this included the design, layout and art work costs in addition to the cost of printing. In 1984, when it was only necessary to make modifications to the diary's design, this cost was reduced to $ 2 140. The other materials cost a total of $ 1 760 and $ 1 655 in 1983 and 1984 respectively.

Other costs

In 1983, other costs included $ 1 300 for design consultation and art work for the brochures and posters, $ 1 250 for the 25 nights that DFO staff spent at the lodge for training and observing, $ 1 800 to get them there, and postage costs (for returning diaries, pins, and crests) of about $ 200. As no DFO staff were sent to the lodge in 1984 and the design consultation required was minimal (costing only $ 150), only the postage costs were the same in both years.

Data analysis costs were not estimated. The data analysis involved in this study was largely experimental and not indicative of what would be required for an ongoing diary program. There is however, no reason to anticipate data analysis costs significantly higher or lower than those associated with a traditional creel census.

DISCUSSION

HOW THE DIARY PROGRAM WORKED

Participation

The response rates of 63 and 59% are in line with other passive (e.g. mail-out) surveys conducted by the department (K. Brickley, DFO, Ottawa, personal communication), but lower than anticipated. We thought the involvement of the lodge would lead to more co-operation from the anglers.

In 15 creel censuses from 1972 through 1980 (Falk et al. 1973, 1974 and 1975; Moshenko and Gillman 1978; Falk et al. 1982; Gillman and Roberge 1982.) DFO achieved an average coverage of 66.5% (41.2 - 91.7%) of the lodges' operating days. Because not all days were covered in the creel censuses and because all guests were not always interviewed on the days covered, it was not possible to collect data on each angler's entire fishing trip. As a result, a response rate in terms of the percentage of guests sampled can not be calculated to compare with the coverage of the angler diary study.

However, calculating the percent of the total number of guest days covered by this study gives some indication of how the coverage of the two methods compare, provided that most guests present at the lodge were interviewed on the days that the creel censuses covered. In 1983, 66% of the total guest days at the lodge were sampled and 60% were sampled in 1984. The coverage in terms of the days of fishing activity sampled is therefore similar for the two methods, but the timing of the sampling differs. Creel censuses have high response rates during the sampling periods, but the sampling periods have not typically covered the whole fishing season. In contrast, the diary method has a lower response rate, but the whole fishing season is sampled.

When using the diary method, good response and low error rates depend largely on the attitudes of anglers. A strong correlation was observed between anglers' willingness to participate and their personal views on the importance of fisheries conservation and management. While many anglers felt it was important to develop a cost effective method to collect data for fisheries management, some were apprehensive about the accuracy of data supplied by anglers and others felt that data collection is strictly a job for government.

All respondents were given a lapel pin and a crest when their diaries were returned. Although we had no way to assess whether these provided any significant incentive to participate in the pilot study, because of their relatively small cost, they were used in both years.

The lodge's participation

DFO's field observations in 1983 were that the lodge conducted the diary program satisfactorily. The most notable problem was the lack of enthusiasm among both the lodge management and staff. As a result, guests were not always told why the data was needed or the importance of complete and accurate record keeping. In addition, because of his other duties, the amount of assistance the fish shed operator could provide to anglers was not always adequate. Generally, it appeared that since the lodge's primary concern was to meet the needs of their guests, they operated the program with as little involvement from their staff as possible.

There were no DFO staff at the lodge during the 1984 season, but the operation of the program did not indicate any changes in the lodge's attitude. This pilot study has taught us that DFO cannot depend too heavily on lodges to collect accurate data from anglers. The less support from the lodge, the more dependent the program became on the anglers' committment to fisheries conservation, their abilities to follow written instructions, and the design of the diary. Finding ways of improving co-operation from the lodges is important, and not only for an angler diary program, but for any type of monitoring program that DFO may conduct on Great Bear and Great Slave Lakes.

Diary design and data errors

The design of the diary is critical to the success of this monitoring method, especially when only a limited amount of support from the lodge can be expected. Errors found in the data collected in 1983 indicated design problems that we tried to address when the diary was redesigned for the 1984 program.

The 1983 design was based on the assumption that anglers would record their catches as they occurred, but it was found that most preferred to fill out their diaries at the end of the day. The circling method of recording catches was then either too tedious or simply misunderstood and some anglers circled just the row

number corresponding to the total number of fish they had caught. When this was done, data on the species, the area of catch, and the use of the catch was not provided for each fish caught.

Since it was clear that data would not be recorded while fishing, in 1984 the catch portion of the diary was changed to require that anglers write the number of fish they had caught, kept, released and used for shore lunch in each area they had fished. In addition, because there were also a large number of errors made in recording where the fish were caught, we concluded that anglers unfamiliar with the lake had difficulty identifying five separate areas. In 1984 the number of areas was reduced from five to three.

A second error attributable to the 1983 design of the diary was that many anglers did not separate their fishing effort by the species they were trying to catch or by the areas they were fishing. This problem was addressed both by the reduction in the number of areas and by a change in the effort portion of the diary so that anglers recorded the area they were fishing first, and the species fished for last.

These changes lead to a reduction in the amount of missing data on areas from 15% to 5% of the total angler days, but the problem of unknown target species increased very slightly from 6% to 7% of the total angler days.

The arrival and departure days also caused problems in 1983 because some anglers fished on these days, but many did not. In the diary, the days were numbered 1 to 8. Anglers who fished on their arrival days filled out day 1 with that day's activity, but those who waited until the following day to fish, filled out the diary's day 1 with the following day's fishing activity. There was a similar problem on the departure days. Consequently, it was not always possible to determine whether an angler had fished on his arrival and departure days and simply failed to record it, or actually did not fish on those days.

To deal with this problem, the 1984 version of the diary had "Record for Day of Arrival" in large coloured letters on the top of the first page of the diary. The subsequent pages were headed "Record for Day 2" through to "Record for Day 8" in the same typeface and colour. Likely as a result of this change, the number of anglers with missing or ambiguous data for their first days dropped from 27% in 1983 to 8% in 1984, but the problem with the last days remained at about 15% during both years.

Because anglers not fishing on the last day probably do not even open their diaries, this problem cannot be solved by any further changes in design. Instead, we have assumed that these days are non-fishing days. This is probably a safe assumption as there is generally little time to fish on the last day and any fish caught cannot be taken home because there is not enough time to freeze it. This was confirmed by our field observations and by discussions with the lodge staff.

The lodge often flew anglers to nearby "inland" lakes to fish, but because this was overlooked in the planning of the study, the 1983 diary did not have a place suitable for recording fishing activity on these lakes. Anglers were instructed not to report any non-Great Slave Lake fishing activity, but if they forgot, the data recorded would have been included in the sample. The potential for this problem was eliminated by adding an area called "off map" to both the catch and effort portion of the 1984 diary.

The 1983 data contained a number of angler days with complete effort data, but no catch information. In retrospect, we realized that we had no way of determining if no fish had been caught on these days, or if the data was simply not recorded. The 1984 design included a check box for each day that allowed anglers to indicate if they had caught no fish.

Many of the data problems witnessed in both years of the diary program could have been avoided if the anglers had clearly understood how to fill out the diary. After examining the 1983 data, our impression was that many data errors were the result of inadequate instructions. The instructions were expanded in the 1984 diary, but the reductions in the error rates appeared to be more likely a result of an improved diary design. This has lead us to believe that many anglers did not read the instructions, either because of their length and apparent complexity, or because the diary looked easy to complete and anglers assumed that it was not necessary.

COST EFFECTIVENESS

It is common practice for DFO to require commercial fisheries users to provide information free of charge (see Section 48 of the Fisheries Act) and to ask recreational users to volunteer information. However, because the co-operation and goodwill of the lodge were considered essential to the success of this study, the lodge was paid to promote and manage the diary program. While this can be seen as setting a precedent for future data collection activities undertaken by the department, we felt the approach was justified because of the experimental nature of this study.

The primary purpose of the fees was to engender co-operation from the lodge. In this regard, the level of payment was based less on what was appropriate compensation for the time and effort involved in managing the program, and more on ensuring that it would be acceptable to the lodges without haggling.

Many of the 1983 expenses were higher than those projected for an ongoing program. This was particularly true for the diary as much of its cost related to its design. Another factor was the expensive materials used for the diary which proved to be unnecessary. The cost of using an angler diary for data collection is about $ 3 400 if the possible savings are taken into consideration and could be reduced further by quantity discounts on the diaries and other materials.

It is difficult to compare the estimated cost of an angler diary program with the cost of creel censuses because catch and effort data are only part of the data collected when DFO staff are at a lodge. Nevertheless, the direct costs of a creel census were conservatively estimated to be about $ 6 000. This includes hiring casual staff (usually summer students), transportation to and from the lodge, room and board at the lodge, and equipment and supplies.

TOTAL CATCH AND EFFORT ESTIMATES

The estimation procedure used in this study (equations 1 and 2, page 7) differs from that used by Falk et al. (1973, 1974, 1975) and in subsequent creel census studies of Great Slave and Great Bear Lakes. (i.e. Moshenko and Gillman 1978; Falk et al. 1982; Gillman and Roberge 1982). An angler-day, represented by an interview with an angler, was the sampling unit used by Falk et al. (1973, 1974, 1975, 1982). Ideally, they would have interviewed all guests every day of

the lodge's season, but in practice their census period did not cover the entire season and it was usually impossible to interview all guests every day. As with the method used in this study, it was necessary to estimate total catch and effort. The method they used to do this is shown algebraically as follows:

$$\hat{C} = c \times \frac{a}{i} \times \frac{D}{d} \qquad (3)$$

where: $\hat{C}$ = estimated total catch
c = total catches summed across all interviewed anglers
i = the total number of interviews conducted
a = estimated total number of fishing interviews that could have been conducted in the census period
d = the number of days on which interviews were conducted
D = the total number of operating days in the lodge's season

On each day interviews were conducted, all guests, interviewed or not, were counted. This count was adjusted to provide an estimate of the number of potential interviews for that day by subtracting those guests who did not fish or who fished on other lakes not included in the creel census (Falk et al. 1974). The adjustment was based on the interviewer's observations of angling activity and his or her discussions with guides and other lodge personnel. The summation of these estimated potential interviews across the census period is the a of equation (3). Multiplying the total sample catch and effort by the ratio of a over the total number of interviews, i, gives an estimate of the total catch and effort of all guests at the lodge during the census period. Multiplying this by the ratio of the number of days in the season, D, over the number of days in the census period, d, gives an estimate of the catch and effort of all guests at the lodge during the entire season.

The accuracy of this estimate hinges on two factors. First, it depends on how well the interviewer estimated the potential interviews each day. It may have be difficult to determine the exact number of guests at the lodge at any one time and to distinguish between those who did not fish, those who flew out to another lake to fish, and those who fished but were not interviewed. In addition, there was likely a tendency for interviewers to over-estimate the potential number of interviews, a, because they were instructed to take a conservative approach and keep the number of assumptions (interviewer bias) about angling activity to a minimum (M. Roberge, DFO, Winnipeg, personal communication).

Secondly, multiplying by the ratio of the number of days in the season over the number of days in the census period is only appropriate if the days not sampled are similar to the days that were, in terms of levels of fishing activity and catch rates. This was not generally true. The census period usually excluded days at the beginning or the end of the lodge's season when a number of factors (i.e. lodge's start-up, expected fishing success, etc.) contribute to substantially fewer guests staying at the lodge.

Both of these factors may cause a consistent over-estimation of total catch and effort when creel censuses are used. The first factor is not a problem when the angler diary method is used because the control sheet provides an exact count of the non-respondents and their days at the lodge. Any inaccuracy in the total

estimates calculated from data collected by an angler diary would come from non-response bias, but the analysis presented in Appendix 3 indicates that, for the pilot study at least, this is not a problem. Even if non-response bias proves significant in future angler diary programs, because it can be measured, it can be corrected.

The second factor described above would only be a problem with the angler diary if the response rate is much lower at the beginning and end of the season. Although the manager's illness caused a sharp drop in the response rate at the end of the season in 1983, there is normally no reason to expect this to happen.

CONCLUSIONS AND RECOMMENDATIONS

This study has shown the potential for an angler diary to provide catch and effort estimates that are more precise than those provided by creel censuses, and at a cost estimated to be 40% less. The response rates achieved were adequate for making reliable estimates and, if a higher degree of co-operation is obtained from the lodges, may be improved. The errors made by anglers in filling out their diaries lowered the quality of the sample data, but not to the extent of seriously impairing the accuracy of the total angling catch and effort estimates, and can be reduced by further improvements in the diary's design.

In creel censuses, on-site interviewers are trained to record information correctly and are able to reject obviously biased data before it is included in the sample. The angler diary will always have a relatively higher error rate, but improvements in the diary's design and adequate instruction and support from the lodges can reduce it to a fully acceptable level.

Improvements in the diary's design should take into account the likelihood that many anglers will not read the instructions. The correct way to fill out the diary should be evident from its format. To achieve this the following design changes are recommended:

- a table format should replace the circling of codes for the target species, the area fished, the species caught and the area of catch.
- the effort and the catch should be recorded on the same table. Anglers would then record the number of hours fished for each species in each area on the same line that they record number of fish caught, kept, released and used for shore lunch.
- an example of how the diary looks when filled out correctly and only the most important instructions printed in large letters can replace the current complex and lengthy instructions. This will allow anglers to ensure that they are filling out the diary correctly with a minimum of reading.
- the questions asking anglers if they fished and if they caught any fish on a particular day should be made very prominent to reduce the likelihood of missing data.

If the angler diary is to be used on a continuing basis as the sole monitoring system for a fishery, it is also recommended that periodic telephone surveys be conducted with non-respondents to ensure that the data is not affected by non-response bias. It is also important that the validity of assumptions made in the process of making population estimates is also examined.

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Appendix 1. Sample pages of the 1983 version of the angler diary.

ANGLER'S DIARY

№ 60060

Name _____

We're counting on you

How to use your Angler's Diary:

1. Please make sure your name is on the front of this booklet.
2. Fill in date at top of form. For each day of your fishing trip use one Angler's Daily Record form.
3. If you do not fish on any given day(s) indicate by checking at the top of that day's form.
4. Each day circle the species you fished for, beginning at line 1 of Your Effort Diary.*

   At the end of each day write in the number of hours spent **actually fishing** — do not include travel or lunch time. Circle the grid location number indicating where you fished. You will find the grid location map in the centre of this booklet. If you fished in more than one location please make a separate entry.

   If you switch from one species to another, indicate this on a separate line of Your Effort Diary.
5. On Your Catch Record, for each fish caught circle the species code*, the appropriate catch use code* and the grid location number.
6. On your last day, before turning in your Angler's Diary to the camp manager, please fill out Your Trophy Record form on the inside back cover.

* Please see inside back cover for all codes. Any questions? See your guide or camp manager.

Diary cover page and instructions.

Angler's Daily Record Date_____

IF YOU DID NOT FISH TODAY CHECK ☐ Day 1

YOUR EFFORT DIARY

	SPECIES FISHED FOR	HOURS FISHED	GRID LOCATION
1	T G NP _	____hrs.	1 2 3 4 5
2	T G NP _	____hrs.	1 2 3 4 5
3	T G NP _	____hrs.	1 2 3 4 5
4	T G NP _	____hrs.	1 2 3 4 5

YOUR CATCH DIARY

FISH NUMBER	SPECIES CAUGHT	CATCH USE	GRID LOCATION
1	T G NP _	K R SL	1 2 3 4 5
2	T G NP _	K R SL	1 2 3 4 5
3	T G NP _	K R SL	1 2 3 4 5
4	T G NP _	K R SL	1 2 3 4 5
5	T G NP _	K R SL	1 2 3 4 5
6	T G NP _	K R SL	1 2 3 4 5
7	T G NP _	K R SL	1 2 3 4 5
8	T G NP _	K R SL	1 2 3 4 5
9	T G NP _	K R SL	1 2 3 4 5
10	T G NP _	K R SL	1 2 3 4 5
11	T G NP _	K R SL	1 2 3 4 5

IF YOU CATCH MORE THAN 11 PLEASE USE NEXT PAGE

YOUR CATCH DIARY

FISH NUMBER	SPECIES CAUGHT	CATCH USE	GRID LOCATION
12	T G NP _	K R SL	1 2 3 4 5
13	T G NP _	K R SL	1 2 3 4 5
14	T G NP _	K R SL	1 2 3 4 5
15	T G NP _	K R SL	1 2 3 4 5
16	T G NP _	K R SL	1 2 3 4 5
17	T G NP _	K R SL	1 2 3 4 5
18	T G NP _	K R SL	1 2 3 4 5
19	T G NP _	K R SL	1 2 3 4 5
20	T G NP _	K R SL	1 2 3 4 5
21	T G NP _	K R SL	1 2 3 4 5
22	T G NP _	K R SL	1 2 3 4 5
23	T G NP _	K R SL	1 2 3 4 5
24	T G NP _	K R SL	1 2 3 4 5
25	T G NP _	K R SL	1 2 3 4 5
26	T G NP _	K R SL	1 2 3 4 5
27	T G NP _	K R SL	1 2 3 4 5
28	T G NP _	K R SL	1 2 3 4 5
29	T G NP _	K R SL	1 2 3 4 5

YOUR NOTES ON TODAY'S FISHING

Two pages of the diary for recording the first day's fishing activity.

1. **Fish Species Coding**

You will find these codes printed on your daily form.

When fishing for these species print appropriate code in space provided.

- T Lake Trout
- G Arctic Grayling
- NP Northern Pike
- W Walleye
- WH Whitefish
- I Inconnu
- C Ciscoes
- S Suckers
- AC Arctic Char
- O Other

2. **Catch Use Coding**

On the daily form, please indicate by circling the appropriate code how you dispose of each fish caught.

- K Kept
- R Released
- SL Shore Lunch

YOUR TROPHY RECORD			
WEIGHT	SIZE (fork length)	GIRTH	GRID LOCATION
___ ___ lbs. oz. or ___ kg	___ in. or ___ cm	___ in. or ___ cm	1 2 3 4 5

Last page of the diary with an explanation of the codes and space for recording information on a trophy catch.

Appendix 2. Sample pages of the 1984 version of the angler diary.

How to use your Angler's Diary:

1. Please print your name on the front cover of your diary.
2. Record day and month (calendar inside back cover).
   Please use a new page for every day of your stay including arrival and departure days.
3. If you don't fish on a given day please check (✓).
4. Circle the area fished (see area map in centre of diary). If you switch from one area to another, use a new line. If you fished at an area not marked on the map, circle OFF MAP.
   Indicate the number of hours fished in each area. Hours fished includes your **actual** fishing time but not your travel and lunch time.
5. Circle the species you were fishing for: i.e. T = Lake Trout. See species codes on inside back cover. If you switch from one species to another, use a separate line.
6. If you fished but did not catch anything, please check (✓).
7. Circle the area code for each area fished; if you switch from one area to another, use a new section.
8. Circle the species caught.
   Record the total number of each species caught and the number kept, released or eaten as shore lunch.
9. If you are keeping a trophy size trout please fill in Trophy Record on centre pages.
10. On the day of your departure please return your diary to the camp manager.

Pages for notes throughout the diary are provided for your personal use.

Sample Record Date 6 / 7 (day / month)

IF YOU DID NOT FISH TODAY CHECK ☐

YOUR EFFORT DIARY

AREA FISHED	HOURS FISHED	SPECIES FISHED FOR
1 (2) 3 OFF MAP	2½ hrs	(T) G NP ___
1 2 (3) OFF MAP	1 hrs	(T) G NP ___
1 2 3 OFF MAP	___ hrs	T G NP ___
1 2 3 OFF MAP	___ hrs	T G NP ___

IF NO FISH CAUGHT TODAY CHECK ☐

YOUR CATCH DIARY

SPECIES	NUMBER OF FISH CAUGHT	KEPT	RELEASED	SHORE LUNCH
FISH CAUGHT IN AREA 1 (2) 3 OFF MAP				
(T) G NP ___	1		1	
T G NP ___				
T G NP ___				
FISH CAUGHT IN AREA 1 2 (3) OFF MAP				
(T) G NP ___	2	1	1	
T G NP ___				
T G NP ___				
FISH CAUGHT IN AREA 1 2 3 OFF MAP				
T G NP ___				
T G NP ___				
T G NP ___				

Record for Day 2 **Date** ____ / ____ (day / month)

IF YOU DID NOT FISH TODAY CHECK ☐

YOUR EFFORT DIARY		
AREA FISHED	HOURS FISHED	SPECIES FISHED FOR
1 2 3 OFF MAP	____ hrs	T G NP ____
1 2 3 OFF MAP	____ hrs	T G NP ____
1 2 3 OFF MAP	____ hrs	T G NP ____
1 2 3 OFF MAP	____ hrs	T G NP ____

IF NO FISH CAUGHT TODAY CHECK ☐

YOUR CATCH DIARY				
SPECIES	NUMBER OF FISH			
	CAUGHT	KEPT	RELEASED	SHORE LUNCH
FISH CAUGHT IN AREA 1 2 3 OFF MAP				
T G NP ____				
T G NP ____				
T G NP ____				
FISH CAUGHT IN AREA 1 2 3 OFF MAP				
T G NP ____				
T G NP ____				
T G NP ____				
FISH CAUGHT IN AREA 1 2 3 OFF MAP				
T G NP ____				
T G NP ____				
T G NP ____				

Your Notes for Day 5

Your Notes for Day 6

Pages for the anglers' own notes and for one day of fishing.

Catch, Size and Possession Limits:

1. For Great Slave and Great Bear Lakes

Species	Maximum Daily Limit	Maximum Possession Limit
Lake Trout*	2	3
Arctic Grayling	5	10
Northern Pike	5	10
Walleye	5	10

* You may take home from your fishing trip 2 Lake Trout, of which only one can be over 28 inches fork length.

The possession limit of 3 is to provide for your consumption.

2. For Blachford Lake and some other NWT waters.

Species	Maximum Daily Limit	Maximum Possession Limit
Lake Trout	3	5
Arctic Grayling	5	10
Northern Pike	5	10
Walleye	5	10

For all other species please refer to the 1984 Northwest Territories Sport Fishing Guide.

1. Fish Species Coding

You will find these codes printed on your daily record.

T	Lake Trout
G	Arctic Grayling
NP	Northern Pike

When fishing for these species print appropriate code in space provided.

W	Walleye
WH	Whitefish
I	Inconnu
C	Ciscoes
S	Suckers
AC	Arctic Char
O	Other

1984

JUNE

					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30

JULY

1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

AUGUST

			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

SEPTEMBER

						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30						

Last page of the diary with catch, size and possession limits, an explanation of the species codes, and a calendar of the summer months.

Appendix 3. Non-response bias.

If non-response bias exists in a sample, any estimates on the population from which the sample was drawn are subject to error. To determine if non-response bias was a problem in the data collected by the angler diary program, telephone interviews were conducted with anglers who did not turn in diaries. Because it was not always possible to contact anglers immediately after their fishing trips, their responses were likely affected by recall bias. It was therefore necessary to account for the recall bias before the extent of non-response bias could be determined.

A sample of the respondents were telephoned and told that their diaries had been lost and that DFO needed their assistance in replacing some of the data. They were then asked to try to recall the number of hours they fished on each day of their stay at the lodge and how many fish they had caught. The mean catch and mean effort were calculated from the data recorded in the diaries and then subtracted from the mean catch and mean effort calculated from the data provided on the telephone. The results of these calculations are shown in the following table.

Table A3.1. The differences between the means of the catch and effort recorded in angler diaries and the means of the catch and effort reported in telephone interviews, by length of stay, 1983 and 1984.

	1983		1984	
	4 or 5 day stay	8 day stay	4 or 5 day stay	8 day stay
Number of respondents	147	70	127	60
Number of telephone interviews	48	23	50	23
Difference in mean number of fish caught	15.5	16.0	4.3	11.6
Difference in mean hours of effort	7.4	22.3	6.3	14.2

The data was separated into two groups according to length of stay because of the significant difference in the size of the recall bias between the four or five day guests and those who stayed eight days. The recall bias was also compared between those anglers who were interviewed only one month after their fishing trips and those interviewed three or six months later. Surprisingly, there appeared to be no correlation between the time that had elapsed since the fishing trip and the extent of the recall bias.

The respondents and the interviewed non-respondents were also divided into two groups according to length of stay. The differences between the mean catch and effort of the respondents and the non-respondents for each of the two groups are shown in Table A3.2. Although some of these differences proved to be significantly different from zero when submitted to a t-test, they are still of a magnitude very close to the differences calculated to determine the recall bias. The conclusion from this analysis therefore, is that non-response bias was not a significant factor in the study.

Table A3.2. The differences between the mean total catch, total effort and catch per hour of the non-respondents and the respondents, 1983 and 1984

	1983		1984	
	4 or 5 day stay	8 day stay	4 or 5 day stay	8 day stay
Number of respondents	147	70	127	60
Number of non-respondents interviewed	67	18	59	21
Difference in mean number of fish caught	5.1'	-3.0	7.3'	10.7
Difference in mean hours of effort	3.6'	11.3	7.3'	13.5
Difference in mean catch per hour	0.11	-0.21'	0.04	0.02

' indicates a difference that is statistically different from zero at a 95% confidence interval.

Appendix 4. Catch disposition changes.

When anglers failed to record whether their catch was kept, released, or used for shore lunch, certain assumptions were made that enabled these values to be estimated. To test if the estimated proportions of the total catch of each species kept, released, and used for shore lunch corresponded to the proportions that were actually recorded by the anglers, a chi-square test was performed.

First the data were divided into two groups. Group 1 included only the complete data, as recorded by the anglers, and group 2 was the estimated data. The chi-square test was designed to test whether there was a significant difference between the proportions of the catch kept, released, and used for shore lunch in the two groups. The null hypothesis for the test was that the group and the catch use were independent or, in other words, that the proportions of catch uses were the same for both groups. The calculated chi-square statistic was based on the difference between the observed and the expected proportions of catch use. It was then compared to the theoretical distribution to find the probability of a higher chi-square. If the calculated chi-square is high, indicating large differences between the two groups that cannot be explained by sampling variation alone, the probability of a larger value of chi-square will be low. Generally, any probability of a larger chi-square less than 0.25 will lead to the rejection of the null hypothesis.

Table A4.1 shows the calculated chi-square and the probability of a greater value for each of the species caught. Because the probability of a greater value is greater than 0.25 in all cases, the null hypothesis is accepted. According to this test, there was no significant difference between the proportions of catch use recorded by the responding anglers and the proportions that were estimated.

Table A4.1. Chi-square values and probabilities.

Species	Calculated Chi-square	Theoretical Probability of a Greater Value
Lake Trout	1.6107	0.30
Northern Pike	0.1009	0.95
Arctic Grayling	0.4511	0.80

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